CLAIMS

I claim:

1. A method of forming a memory cell, the method comprising:

providing a substrate having a transistor on a first portion of the substrate, the transistor having a first electrode, and a first conductive layer on a second portion of the substrate;

forming a dielectric layer comprising substoichiometric tantalum pentoxide having a first oxygen content, the dielectric layer overlying the first conductive layer;

conditioning the dielectric layer with sulfur trioxide to define a more highly oxidized tantalum pentoxide layer having a second oxygen content, wherein the second oxygen content is greater than the first oxygen content;

forming a second conductive layer overlying the more highly oxidized tantalum pentoxide layer; and

coupling the first electrode of the transistor to the first conductive layer.

2. The method of claim 1 wherein the memory cell is a dynamic random access memory.

3. The method of claim 1 wherein the substrate comprises silicon.

4. The method of claim 1 wherein the first conductive layer comprises a material selected from the group consisting of: a conductive metal, a conductive metal compound, and a conductive metal alloy.

5. The method of claim 4 wherein the first conductive layer comprises a material selected from the group consisting of platinum, ruthenium, palladium, iridium, rhenium, rhodium, gold, silver, ruthenium oxide, tin oxide, indium

oxide, rhenium oxide, osmium oxide, rhodium oxide, iridium oxide, doped tin oxide, indium oxide, zinc oxide, $YBa_2Cu_3O_{7-x}$, $(La,Sr)CoO_3$, and $SrRuO_3$.

6. The method of claim 1 wherein the dielectric layer is formed by chemical vapor deposition or sputtering.

7. The method of claim 1 wherein the conditioning step is performed at a temperature ranging from 100° to 600°C.

8. The method of claim 1 wherein the conditioning step is performed at a pressure ranging from 0.1 to 10 atmospheres.

9. The method of claim 1 wherein the conditioning step is performed for a time period of at least 10 minutes.

10. The method of claim 9 wherein the conditioning step is performed for a time period of ranging from 10 to 120 minutes.

11. The method of claim 1 wherein the stoichiometric tantalum pentoxide layer has a thickness ranging from 5 to 200 Angstroms.

12. The method of claim 1 wherein the second conductive layer comprises a material selected from the group consisting of a conductive metal, a conductive metal compound, and a conductive metal alloy.

13. The method of claim 12 wherein the second conductive layer comprises a material selected from the group consisting of platinum, palladium, ruthenium, rhodium, gold, iridium, silver, titanium nitride, ruthenium nitride, tin nitride, zirconium nitride, tungsten nitride, ruthenium dioxide, tin oxide, zinc oxide, doped zinc oxide, iridium oxide, titanium silicide, tantalum silicide, tungsten silicide,

molybdenum silicide, nickel silicide, tantalum carbide, titanium boride, tantalum titanium molybdenum, tungsten, aluminum, doped silicon, and doped germanium.

14. A method of forming a capacitor, the method comprising:

providing a substrate carrying a first conductive layer;

forming a first metal oxide layer overlying the first conductive layer, the first metal oxide layer being substoichiometric;

defining a second metal oxide layer by exposing the first metal oxide layer to sulfur trioxide under reaction conditions effective to oxidize the first metal oxide layer; and

forming a second conductive layer overlying the second metal oxide layer.

15. The method of claim 14 wherein the substrate comprises silicon.

16. The method of claim 14 wherein the first conductive layer comprises a material selected from the group consisting of a conductive metal, a conductive metal compound, and a conductive metal alloy.

17. The method of claim 16 wherein the first conductive layer comprises a material selected from the group consisting of platinum, ruthenium, palladium, iridium, rhenium, rhodium, gold, silver, ruthenium oxide, tin oxide, indium oxide, rhenium oxide, osmium oxide, rhodium oxide, iridium oxide, doped tin oxide, indium oxide, zinc oxide, $YBa_2Cu_3O_{7-x}$, $(La,Sr)CoO_3$, and $SrRuO_3$.

18. The method of claim 14 wherein the first metal oxide layer comprises an oxide of a transition metal.

19. The method of claim 18 wherein the first metal oxide layer is substoichiometric tantalum pentoxide.

20. The method of claim 14 wherein the first metal oxide layer is formed by chemical vapor deposition or sputtering.

21. The method of claim 14 wherein the second metal oxide layer is substantially stoichiometric tantalum pentoxide.

22. The method of claim 14 wherein the second metal oxide layer has a thickness ranging from 5 to 200 Angstroms.

23. The method of claim 14 wherein the exposing step is performed at a temperature ranging from 100° to 600°C.

24. The method of claim 14 wherein the exposing step is performed at a pressure ranging from 0.1 to 10 atmospheres.

25. The method of claim 14 wherein the exposing step is performed for a time period of at least 10 minutes.

26. The method of claim 25 wherein the exposing step is performed for a time period ranging from 10 to 120 minutes.

27. The method of claim 14 wherein the second conductive layer comprises a material selected from a conductive metal, a conductive metal compound, and a conductive metal alloy.

28. The method of claim 27 wherein the second conductive layer comprises a material selected from the group consisting of platinum, palladium, ruthenium, rhodium, gold, iridium, silver, titanium nitride, ruthenium nitride, tin nitride, zirconium nitride, tungsten nitride, ruthenium dioxide, tin oxide, zinc oxide, doped zinc oxide, iridium oxide, titanium silicide, tantalum silicide, tungsten silicide,

molybdenum silicide, nickel silicide, tantalum carbide, titanium boride, tantalum titanium molybdenum, tungsten, aluminum, doped silicon, and doped germanium.

29. A method of increasing the oxygen content of a substoichiometric metal oxide layer, the method comprising:

placing the substoichiometric metal oxide layer in a processing station; and

exposing the substoichiometric metal oxide layer, while the substoichiometric metal oxide layer is in the processing station, to sulfur trioxide under reaction conditions effective to oxidize the substoichiometric metal oxide layer.

30. The method of claim 29 wherein the substoichiometric metal oxide layer comprises an oxide of a transition metal.

31. The method of claim 30 wherein the substoichiometric metal oxide layer is substoichiometric tantalum pentoxide.

32. The method of claim 29 wherein the substoichiometric metal oxide layer is formed by chemical vapor deposition or sputtering.

33. The method of claim 29 wherein the substoichiometric metal oxide layer has a thickness ranging from 5 to 200 Angstroms.

34. The method of claim 29 wherein the processing station is a chemical vapor deposition chamber.

35. The method of claim 29 wherein the exposing step is performed at a temperature ranging from 100° to 600°C.

36. The method of claim 29 wherein the exposing step is performed at a pressure ranging from 0.1 to 10 atmospheres.

37. The method of claim 29 wherein the exposing step is performed for a time period of at least 10 minutes.

38. The method of claim 37 wherein the exposing step is performed for a time period of ranging from 10 to 120 minutes.

39. A method of forming a selected metal oxide layer overlying a substrate, the method comprising:

forming a first metal oxide layer having a first oxygen content overlying the substrate; and

conditioning the first metal oxide layer with sulfur trioxide to define the selected metal oxide layer having a second oxygen content, wherein the second oxygen content is greater than the first oxygen content.

40. The method of claim 39 wherein the substrate comprises silicon having a first conductive layer.

41. The method of claim 39 wherein the first metal oxide layer comprises an oxide of a transition metal.

42. The method of claim 41 wherein the first metal oxide layer is substoichiometric tantalum pentoxide.

43. The method of claim 39 wherein the first metal oxide layer is formed by chemical vapor deposition or sputtering.

44. The method of claim 39 wherein the conditioning step is performed at a temperature ranging from 100° to 600°C.

45. The method of claim 39 wherein the conditioning step is performed at a pressure ranging from 0.1 to 10 atmospheres.

46. The method of claim 39 wherein the conditioning step is performed for a time period of at least 10 minutes.

47. The method of claim 46 wherein the exposing step is performed for a time period ranging from 10 to 120 minutes.

48. The method of claim 39 wherein the first metal oxide layer has a thickness ranging from 5 to 200 Angstroms.

49. The method of claim 39 wherein the selected metal oxide layer comprises an oxide of a transition metal.

50. The method of claim 39 wherein the selected metal oxide layer is substantially stoichiometric tantalum pentoxide.

51. A method of forming a computer, the method comprising:

providing a data input device;

providing a data output device;

providing computing circuitry coupled to the data input and output devices, the computing circuitry including a memory cell, the memory cell is formed by steps comprising:

providing a transistor on a first portion of a substrate, the transistor having a first electrode;

forming a first conductive layer on a second portion of the substrate;

forming a dielectric layer comprising substoichiometric tantalum pentoxide having a first leakage current, the dielectric layer overlying the first conductive layer;

conditioning the dielectric layer with sulfur trioxide to define a substantially stoichiometric tantalum pentoxide layer having a second leakage current, wherein the second leakage current is less than the first leakage current;

forming a second conductive layer overlying the stoichiometric tantalum pentoxide layer; and

coupling the first electrode of the transistor to the first conductive layer.

52. The method of claim 51 wherein the memory cell is dynamic random access memory.

53. The method of claim 51 wherein the substrate comprises silicon.

54. The method of claim 51 wherein the first conductive layer comprises a material selected from the group consisting of a conductive metal, a conductive metal compound, and a conductive metal alloy.

55. The method of claim 54 wherein the first conductive layer comprises a material selected from the group consisting of platinum, ruthenium, palladium, iridium, rhenium, rhodium, gold, silver, ruthenium oxide, tin oxide, indium oxide, rhenium oxide, osmium oxide, rhodium oxide, iridium oxide, doped tin oxide, indium oxide, zinc oxide, $YBa_2Cu_3O_{7-x}$, $(La,Sr)CoO_3$, and $SrRuO_3$.

56. The method of claim 51 wherein the dielectric layer is formed by chemical vapor deposition or sputtering.

57. The method of claim 51 wherein the conditioning step is performed at a temperature ranging from 100° to 600°C.

58. The method of claim 51 wherein the conditioning step is performed at a pressure ranging from 0.1 to 10 atmospheres.

59. The method of claim 53 wherein the conditioning step is performed for a time period of at least 10 minutes.

60. The method of claim 59 wherein the conditioning step is performed for a time period of ranging from 10 to 120 minutes.

61. The method of claim 51 wherein the stoichiometric tantalum pentoxide layer has a thickness ranging from 5 to 200 Angstroms.

62. The method of claim 51 wherein the second dielectric constant is ranges from 15 to 23.

63. The method of claim 51 wherein the second conductive layer comprises a material selected from the group of a conductive metal, a conductive metal compound, and a conductive metal alloy.

64. The method of claim 63 wherein the second conductive layer comprises a material selected from the group consisting of platinum, palladium, ruthenium, rhodium, gold, iridium, silver, titanium nitride, ruthenium nitride, tin nitride, zirconium nitride, tungsten nitride, ruthenium dioxide, tin oxide, zinc oxide, doped zinc oxide, iridium oxide, titanium silicide, tantalum silicide, tungsten silicide, molybdenum silicide, nickel silicide, tantalum carbide, titanium boride, tantalum titanium molybdenum, tungsten, aluminum, doped silicon, and doped germanium.

65. A composition comprising a metal oxide layer in contact with sulfur trioxide.